

What is claimed is:

1. A method of performing an injection operation comprising the steps of:
introducing a water-soluble relative permeability modifier into a subterranean formation; and
injecting an aqueous injection fluid into the subterranean formation after introducing the water-soluble relative permeability modifier.
2. The method of claim 1 wherein the hydrophobically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.
3. The method of claim 1 wherein the hydrophobically modified water-soluble polymer comprises a polymer backbone comprising polar heteroatoms.
4. The method of claim 3 wherein the polar heteroatoms present within the polymer backbone of the hydrophobically modified water-soluble polymer comprise oxygen, nitrogen, sulfur, or phosphorous.
5. The method of claim 1 wherein the hydrophobically modified water-soluble polymer is a reaction product of a hydrophilic polymer and a hydrophobic compound.
6. The method of claim 5 wherein the hydrophilic polymer comprises a dialkyl amino pendant group.
7. The method of claim 5 wherein the hydrophilic polymer comprises a dimethyl amino pendant group and at least one monomer comprising dimethylaminoethyl methacrylate or dimethylaminopropyl methacrylamide.
8. The method of claim 5 wherein the hydrophilic polymer comprises a polyvinylamine, a poly(vinylamine/vinyl alcohol), or an alkyl acrylate polymer.
9. The method of claim 5 wherein the hydrophilic polymer comprises polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylic acid/dimethylaminoethyl methacrylate), poly(methacrylic acid/dimethylaminoethyl methacrylate), poly(2-acrylamido-2-methyl propane sulfonic acid/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide), poly(acrylic acid/dimethylaminopropyl methacrylamide), or poly(methacrylic acid/dimethylaminopropyl methacrylamide).
10. The method of claim 5 wherein the hydrophilic polymer comprises a polymer backbone comprising polar heteroatoms.

11. The method of claim 10 wherein the hydrophilic polymer comprises a cellulose, a chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone, or a starch.
12. The method of claim 5 wherein the hydrophobic compound comprises an alkyl halide, a sulfonate, a sulfate, or an organic acid derivative.
13. The method of claim 12 wherein the organic acid derivative comprises an octenyl succinic acid; a dodecenyl succinic acid; or an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.
14. The method of claim 5 wherein the hydrophobic compound has an alkyl chain length of from about 4 to about 22 carbons.
15. The method of claim 5 wherein the reaction between the hydrophilic polymer and the hydrophobic compound to form the hydrophobically modified water-soluble polymer occurs *in-situ* after injection of a treatment fluid comprising the hydrophilic polymer, the hydrophobic compound, and a surfactant into the subterranean formation.
16. The method of claim 15 wherein the hydrophilic polymer is present in the treatment fluid in an amount in the range of from about 0.1% to about 10% by weight of the treatment fluid.
17. The method of claim 15 wherein the hydrophobic compound is present in the treatment fluid in an amount in the range of from about 0.01% to about 5% by weight of the treatment fluid.
18. The method of claim 15 wherein the surfactant comprises an alkyl ammonium surfactant, a betaine, an alkyl ether sulfate, an alkyl ether sulfonate, or an ethoxylated alcohol.
19. The method of claim 15 wherein the treatment fluid further comprises a pH-adjusting agent that adjusts the pH to at least about 8.
20. The method of claim 15 further comprising the step of shutting the well bore for a period of up to about 24 hours after injection of the treatment fluid.
21. The method of claim 1 wherein the hydrophobically modified water-soluble polymer is prepared from a polymerization reaction of at least one hydrophilic monomer and at least one hydrophobically modified hydrophilic monomer.
22. The method of claim 21 wherein the hydrophilic monomer comprises acrylamide; 2-acrylamido-2-methyl propane sulfonic acid; N,N-dimethylacrylamide; vinyl pyrrolidone;

dimethylaminoethyl methacrylate; acrylic acid; dimethylaminopropylmethacrylamide; vinyl amine; vinyl acetate; trimethylammoniummethyl methacrylate chloride; methacrylamide; hydroxyethyl acrylate; vinyl sulfonic acid; vinyl phosphonic acid; methacrylic acid; vinyl caprolactam; N-vinylformamide; N,N-diallylacetamide; dimethyldiallyl ammonium halide; itaconic acid; styrene sulfonic acid; methacrylamidoethyltrimethyl ammonium halide; a quaternary salt derivative of acrylamide; or a quaternary salt derivative of acrylic acid.

23. The method of claim 21 wherein the hydrophobically modified hydrophilic monomer comprises an alkyl acrylate, an alkyl methacrylate, an alkyl acrylamide, an alkyl methacrylamide, an alkyl dimethylammoniummethyl methacrylate halide, or an alkyl dimethylammoniumpropyl methacrylamide halide, wherein the alkyl groups have from about 4 to about 22 carbon atoms.

24. The method of claim 21 wherein the mole ratio of the hydrophilic monomer to the hydrophobically modified hydrophilic monomer in the hydrophobically modified water-soluble polymer is in the range of from about 99.98:0.02 to about 90:10.

25. The method of claim 1 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a permeability-modifying injection fluid comprising an aqueous injection fluid and the water-soluble relative permeability modifier into the subterranean formation.

26. The method of claim 25 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.

27. The method of claim 25 wherein the permeability-modifying injection fluid was formed by metering the water-soluble relative permeability modifier into an existing injection stream comprising the aqueous injection fluid to form the permeability-modifying injection fluid.

28. The method of claim 1 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a treatment fluid comprising the water-soluble relative permeability modifier into the subterranean formation.

29. The method of claim 28 wherein the water-soluble relative permeability modifier is present in the treatment fluid in an amount in the range of from about 0.02% to about 10% by weight of the treatment fluid.

30. A method of performing an injection operation comprising the steps of:
 introducing a water-soluble relative permeability modifier comprising a hydrophilically modified water-soluble polymer into a subterranean formation; and
 injecting an aqueous injection fluid into the subterranean formation after introducing the water-soluble relative permeability modifier.

31. The method of claim 30 wherein the hydrophilically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.

32. The method of claim 30 wherein the hydrophilically modified water-soluble polymer comprises a polymer backbone comprising polar heteroatoms.

33. The method of claim 32 wherein the polar heteroatoms present within the polymer backbone of the hydrophilic polymer comprise oxygen, nitrogen, sulfur, or phosphorous.

34. The method of claim 30 wherein the hydrophilically modified water-soluble polymer is a reaction product of a hydrophilic polymer and a hydrophilic compound.

35. The method of claim 34 wherein the hydrophilic polymer comprises a dialkyl amino pendant group.

36. The method of claim 34 wherein the hydrophilic polymer comprises a dimethyl amino pendant group and at least one monomer comprising dimethylaminoethyl methacrylate or dimethylaminopropyl methacrylamide.

37. The method of claim 34 wherein the hydrophilic polymer comprises a polyvinylamine, a poly(vinylamine/vinyl alcohol), or an alkyl acrylate polymer.

38. The method of claim 34 wherein the hydrophilic polymer comprises polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylic acid/dimethylaminoethyl methacrylate), poly(methacrylic acid/dimethylaminoethyl methacrylate), poly(2-acrylamido-2-methyl propane sulfonic acid/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide), poly(acrylic acid/dimethylaminopropyl methacrylamide), or poly(methacrylic acid/dimethylaminopropyl methacrylamide).

39. The method of claim 34 wherein the hydrophilic polymer comprises a polymer backbone comprising polar heteroatoms.

40. The method of claim 39 wherein the hydrophilic polymer comprises a cellulose, a chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone, or a starch.
41. The method of claim 34 wherein the hydrophilic compound comprises a polyether comprising halogen; a sulfonate; a sulfate; or an organic acid derivative.
42. The method of claim 41 wherein the organic acid derivative comprises an octenyl succinic acid; a dodecenyl succinic acid; or an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.
43. The method of claim 41 wherein the polyether comprises a polyethylene oxide, polypropylene oxide, polybutylene oxide, or a mixture thereof.
44. The method of claim 41 wherein the weight ratio of the hydrophilic polymer to the polyether is in the range of from about 1:1 to about 10:1.
45. The method of claim 34 wherein the reaction between the hydrophilic polymer and the hydrophilic compound to form the hydrophilically modified water-soluble polymer occurs *in-situ* after injection of a treatment fluid comprising the hydrophilic polymer, the hydrophilic compound, and a surfactant into the subterranean formation.
46. The method of claim 45 wherein the hydrophilic polymer is present in the treatment fluid in an amount in the range of from about 0.1% to about 10% by weight of the treatment fluid.
47. The method of claim 45 wherein the hydrophilic compound is present in the treatment fluid in an amount in the range of from about 0.01% to about 5% by weight of the treatment fluid.
48. The method of claim 45 wherein the surfactant comprises an alkyl ammonium surfactant, a betaine, an alkyl ether sulfate, an alkyl ether sulfonate, or an ethoxylated alcohol.
49. The method of claim 45 wherein the treatment fluid further comprises a pH-adjusting agent that adjusts the pH to at least about 8.
50. The method of claim 45 further comprising the step of shutting the well bore for a period of up to about 24 hours after injection of the treatment fluid.
51. The method of claim 30 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a permeability-modifying injection fluid

comprising an aqueous injection fluid and the water-soluble relative permeability modifier into the subterranean formation.

52. The method of claim 51 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.

53. The method of claim 51 wherein the permeability-modifying injection fluid was formed by metering the water-soluble relative permeability modifier into an existing injection stream comprising the aqueous injection fluid to form the permeability-modifying injection fluid.

54. The method of claim 30 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a treatment fluid comprising the water-soluble relative permeability modifier into the subterranean formation.

55. The method of claim 54 wherein the water-soluble relative permeability modifier is present in the treatment fluid in an amount in the range of from about 0.02% to about 10% by weight of the treatment fluid.

56. A method of performing an injection operation comprising the steps of:

providing a water-soluble relative permeability modifier comprising a homo-, co-, or terpolymer of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, dimethylaminoethyl methacrylate, acrylic acid, dimethylaminopropylmethacrylamide, vinyl amine, vinyl acetate, trimethylammoniumethyl methacrylate chloride, methacrylamide, hydroxyethyl acrylate, vinyl sulfonic acid, vinyl phosphonic acid, methacrylic acid, vinyl caprolactam, N-vinylformamide, N,N-diallylacetamide, dimethyldiallyl ammonium halide, itaconic acid, styrene sulfonic acid, methacrylamidoethyltrimethyl ammonium halide, a quaternary salt derivative of acrylamide, or a quaternary salt derivative of acrylic acid;

introducing the water-soluble relative permeability modifier into a subterranean formation; and

injecting an aqueous injection fluid into the subterranean formation after introducing the water-soluble relative permeability modifier.

57. The method of claim 56 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a permeability-modifying injection fluid comprising an aqueous injection fluid and the water-soluble relative permeability modifier into the subterranean formation.

58. The method of claim 57 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.

59. The method of claim 57 wherein the permeability-modifying injection fluid was formed by metering the water-soluble relative permeability modifier into an existing injection stream comprising the aqueous injection fluid to form the permeability-modifying injection fluid.

60. The method of claim 56 wherein the water-soluble relative permeability modifier is introduced into the subterranean formation by injecting a treatment fluid comprising the water-soluble relative permeability modifier into the subterranean formation.

61. The method of claim 60 wherein the water-soluble relative permeability modifier is present in the treatment fluid in an amount in the range of from about 0.02% to about 10% by weight of the treatment fluid.

62. A permeability-modifying injection fluid comprising:
a water-soluble relative permeability modifier comprising a hydrophobically modified water-soluble polymer.

63. The permeability-modifying injection fluid of claim 62 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.

64. The permeability-modifying injection fluid of claim 62 wherein the hydrophobically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.

65. The permeability-modifying injection fluid of claim 62 wherein the hydrophobically modified water-soluble polymer comprises a polymer backbone comprising polar heteroatoms.

66. The permeability-modifying injection fluid of claim 65 wherein the polar heteroatoms present within the polymer backbone of the hydrophobically modified water-soluble polymer comprise oxygen, nitrogen, sulfur, or phosphorous.

67. The permeability-modifying injection fluid of claim 62 wherein the hydrophobically modified water-soluble polymer is a reaction product of a hydrophilic polymer and a hydrophobic compound.

68. The permeability-modifying injection fluid of claim 67 wherein the hydrophilic polymer comprises a dialkyl amino pendant group.

69. The permeability-modifying injection fluid of claim 67 wherein the hydrophilic polymer comprises a dimethyl amino pendant group and at least one monomer comprising dimethylaminoethyl methacrylate or dimethylaminopropyl methacrylamide.

70. The permeability-modifying injection fluid of claim 67 wherein the hydrophilic polymer comprises a polyvinylamine, a poly(vinylamine/vinyl alcohol), or an alkyl acrylate polymer.

71. The permeability-modifying injection fluid of claim 67 wherein the hydrophilic polymer comprises polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylic acid/dimethylaminoethyl methacrylate), poly(methacrylic acid/dimethylaminoethyl methacrylate), poly(2-acrylamido-2-methyl propane sulfonic acid/dimethylaminoethyl

methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide), poly(acrylic acid/dimethylaminopropyl methacrylamide), or poly(methacrylic acid/dimethylaminopropyl methacrylamide).

72. The permeability-modifying injection fluid of claim 67 wherein the hydrophilic polymer comprises a polymer backbone comprising polar heteroatoms.

73. The permeability-modifying injection fluid of claim 72 wherein the hydrophilic polymer comprises a cellulose, a chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone, or a starch.

74. The permeability-modifying injection fluid of claim 67 wherein the hydrophobic compound comprises an alkyl halide, a sulfonate, a sulfate, or an organic acid derivative.

75. The permeability-modifying injection fluid of claim 74 wherein the organic acid derivative comprises an octenyl succinic acid; a dodecenyl succinic acid; or an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.

76. The permeability-modifying injection fluid of claim 67 wherein the hydrophobic compound has an alkyl chain length of from about 4 to about 22 carbons.

77. The permeability-modifying injection fluid of claim 62 wherein the hydrophobically modified water-soluble polymer is prepared from a polymerization reaction of at least one hydrophilic monomer and at least one hydrophobically modified hydrophilic monomer.

78. The permeability-modifying injection fluid of claim 77 wherein the hydrophilic monomer comprises acrylamide; 2-acrylamido-2-methyl propane sulfonic acid; N,N-dimethylacrylamide; vinyl pyrrolidone; dimethylaminoethyl methacrylate; acrylic acid; dimethylaminopropylmethacrylamide; vinyl amine; vinyl acetate; trimethylammoniummethyl methacrylate chloride; methacrylamide; hydroxyethyl acrylate; vinyl sulfonic acid; vinyl phosphonic acid; methacrylic acid; vinyl caprolactam; N-vinylformamide; N,N-diallylacetamide; dimethyldiallyl ammonium halide; itaconic acid; styrene sulfonic acid; methacrylamidoethyltrimethyl ammonium halide; a quaternary salt derivative of acrylamide; or a quaternary salt derivative of acrylic acid.

79. The permeability-modifying injection fluid of claim 77 wherein the hydrophobically modified hydrophilic monomer comprises an alkyl acrylate, an alkyl methacrylate, an alkyl acrylamide, an alkyl methacrylamide, an alkyl dimethylammoniummethyl methacrylate halide, or

an alkyl dimethylammoniumpropyl methacrylamide halide, wherein the alkyl groups have from about 4 to about 22 carbon atoms.

80. The permeability-modifying injection fluid of claim 77 wherein the mole ratio of the hydrophilic monomer to the hydrophobically modified hydrophilic monomer in the hydrophobically modified water-soluble polymer is in the range of from about 99.98:0.02 to about 90:10.

81. A permeability-modifying injection fluid comprising a hydrophilically modified water-soluble polymer.

82. The permeability-modifying injection fluid of claim 81 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.

83. The permeability-modifying injection fluid of claim 62 wherein the hydrophilically modified water-soluble polymer has a molecular weight in the range of from about 100,000 to about 10,000,000.

84. The permeability-modifying injection fluid of claim 62 wherein the hydrophilically modified water-soluble polymer comprises a polymer backbone comprising polar heteroatoms.

85. The permeability-modifying injection fluid of claim 84 wherein the polar heteroatoms present within the polymer backbone of the hydrophilically modified water-soluble polymer comprise oxygen, nitrogen, sulfur, or phosphorous.

86. The permeability-modifying injection fluid of claim 62 wherein the hydrophilically modified water-soluble polymer is a reaction product of a hydrophilic polymer and a hydrophilic compound.

87. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic polymer comprises a dialkyl amino pendant group.

88. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic polymer comprises a dimethyl amino pendant group and at least one monomer comprising dimethylaminoethyl methacrylate or dimethylaminopropyl methacrylamide.

89. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic polymer comprises a polyvinylamine, a poly(vinylamine/vinyl alcohol), or an alkyl acrylate polymer.

90. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic polymer comprises polydimethylaminoethyl methacrylate, polydimethylaminopropyl methacrylamide, poly(acrylamide/dimethylaminoethyl methacrylate), poly(acrylic acid/dimethylaminoethyl methacrylate), poly(methacrylic acid/dimethylaminoethyl methacrylate), poly(2-acrylamido-2-methyl propane sulfonic acid/dimethylaminoethyl methacrylate), poly(acrylamide/dimethylaminopropyl methacrylamide), poly(acrylic

acid/dimethylaminopropyl methacrylamide), or poly(methacrylic acid/dimethylaminopropyl methacrylamide).

91. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic polymer comprises a polymer backbone comprising polar heteroatoms.

92. The permeability-modifying injection fluid of claim 91 wherein the hydrophilic polymer comprises a cellulose, a chitosan, a polyamide, a polyetheramine, a polyethyleneimine, a polyhydroxyetheramine, a polylysine, a polysulfone, or a starch.

93. The permeability-modifying injection fluid of claim 86 wherein the hydrophilic compound comprises a polyether that comprises halogen; a sulfonate; a sulfate; or an organic acid derivative.

94. The permeability-modifying injection fluid of claim 93 wherein the organic acid derivative comprises an octenyl succinic acid; a dodecenyl succinic acid; or an anhydride, ester, or amide of octenyl succinic acid or dodecenyl succinic acid.

95. The permeability-modifying injection fluid of claim 93 wherein the polyether comprises a polyethylene oxide, polypropylene oxide, polybutylene oxide, or a mixture thereof.

96. The permeability-modifying injection fluid of claim 93 wherein the weight ratio of the hydrophilic polymer to the polyether is in the range of from about 1:1 to about 10:1.

97. A permeability-modifying injection fluid comprising:
a water-soluble relative permeability modifier comprising a homo-, co-, or terpolymer of acrylamide, 2-acrylamido-2-methyl propane sulfonic acid, N,N-dimethylacrylamide, vinyl pyrrolidone, dimethylaminoethyl methacrylate, acrylic acid, dimethylaminopropylmethacrylamide, vinyl amine, vinyl acetate, trimethylammoniummethyl methacrylate chloride, methacrylamide, hydroxyethyl acrylate, vinyl sulfonic acid, vinyl phosphonic acid, methacrylic acid, vinyl caprolactam, N-vinylformamide, N,N-diallylacetamide, dimethyldiallyl ammonium halide, itaconic acid, styrene sulfonic acid, methacrylamidoethyltrimethyl ammonium halide, a quaternary salt derivative of acrylamide, or a quaternary salt derivative of acrylic acid.

98. The permeability-modifying injection fluid of claim 97 wherein the water-soluble relative permeability modifier is present in the permeability-modifying injection fluid in an amount in the range of from about 0.02% to about 10% by weight of the permeability-modifying injection fluid.